Sprint's Better Buildings Network Efficiency Strategy

The largest contributor to energy consumption in wireless networks are Base Station Transceivers (BTSs), accounting for more than 50 percent[i] of network energy consumption. Sprint's legacy networks require a separate BTS for each network type, including CDMA (Code Division Multiple Access), PTT (Push To Talk), and 4G wireless services.

During 2012 and 2013, as part of its ongoing Network Vision modernization program, Sprint has made considerable progress in re-engineering the network, deploying outdoor Multimode Base Transceiver Stations (MMBTS) that will support CDMA, PTT, and 4G LTE (Long Term Evolution) wireless services in a single platform. Current plans call to shut down the legacy iDEN network by June 30, 2013. In addition to shutting down approximately 30,000 iDEN Cell Site buildings in favor of an integrated outdoor BTS solution, 48 iDEN switch locations will have all the network equipment shut down and removed, enabling substantial power usage reductions across Sprint's Network Building portfolio. This change in infrastructure design is the major step and key enabler by which Sprint expects to achieve its near term objective of 20% absolute electrical use reduction by 2020.

Sprint's Network Vision

In the 2009-2010 time frame, Sprint developed a new evolutionary concept for its network called Network Vision. The concept included development strategies for both Sprint's 3G and nascent 4G networks. For the 3G Architecture, the fundamental building block was to introduce a new MMBTS. The Multimodal aspect allows Sprint to provide wireless services in multiple spectra which, at the time, required separate discrete networks. The MMBTS supports multiple networks such as the current CDMA, Push- to-Talk, and WiMax networks on a single network platform in a significantly smaller footprint with much lower power consumption as shown in *figure one.* At the cell site level, this means that many redundant power consuming network elements can be consolidated, including cell site routers, rectifiers, battery systems, antennas, remote radio heads, digital units, and baseband units.

Based upon the current 3G wireless technology currently deployed, multiple BTS units are aggregated at Mobile Switching Center (MSC) sites located throughout each of the licensed CDMA band serving areas covered by the Sprint network. With the legacy technology, each market was served by a standalone MSC serving Radio Access Network (RAN) equipment, PSTN (Public Switched Telephone Network) trunks, and miscellaneous outboard signaling networks required for cellular operations. Network Vision replaces these standalone networks with an all IP-based hierarchical network structure that allows greater flexibility and efficiencies that translate into increased energy savings.

It should be noted that while the Network Vision program in and of itself may be capable of allowing Sprint to meet its 20% energy efficiency goal, it does not preclude us from initiating other energy efficiency programs that follow more traditional routes. We expect to achieve major gains through Network Vision, but intend to continuously improve our energy efficiency through a variety of traditional and non-traditional routes.

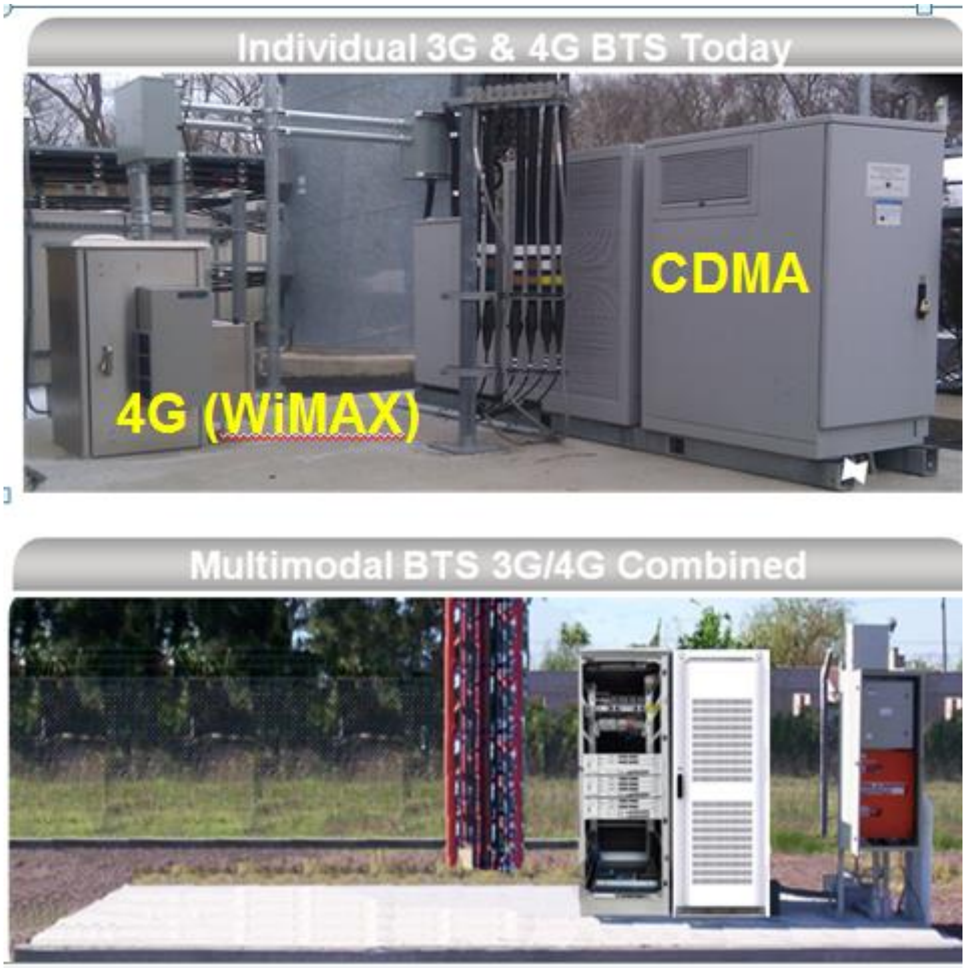

Figure 1- Reduced Network Vision MMBTS Footprint

Network Vision Switch Technology

In addition to the MMBTS concept, the Network Vision program supports a transition of Sprint's network from individual MSCs to an IP-based Host and Satellite switch architecture. IP technology is inherently more energy efficient[ii] than traditional circuit switched networks. As shown in *figure 2*, the bottom layer of the network hierarchy is comprised of small Satellite Switching Offices (SSOs) through which all cell site traffic routes. The SSO is an edge aggregation point for voice and data bearer traffic and a pass-through point for all signaling and control traffic between the cell site and the core wireless switch. SSO equipment can either be collocated at a core switch site, or at physically remote locations. At a high level, the SSO consists of an IP Aggregator, Media Gateway, and Base Station/Radio Network Controllers (BSCs and RNCs).

The next layer up consists of Core Network Vision Wireless Sites which provide a master signaling and control point for multiple SSOs. The Core site does not carry voice and data-bearer traffic, rather it utilizes Wireless Soft Switching technology at the IP layer. The primary point to understand is that this architecture greatly simplifies the network, mitigating the need for traditional, energy intensive, and bulky circuit switching and Time Division Multiplexing equipment.

The Network Vision concept also supports 4G LTE based services. A 4G cell site is called an LTE eNodeB device. While each of Sprint's network vendors has slightly different architectures, the overall principle is the same. The eNodeB equipment is collocated with 3G equipment often in the same equipment cabinet. In addition to the eNodeB, there are LTE specific Remote Radio Heads (RRHs) or Remote Radio Units (RRUs). Both the 3G and 4G services share the same backhaul circuits, including terrestrial and Microwave transport equipment and facilities, yielding additional energy efficiencies. Other 3G/4G shared resources include cell site routers, rectifiers, battery systems, cell antennas, remote radio heads, and Digital Units (DUs) or Baseband Units (BBUs).

Like 3G, all LTE cell data and voice traffic is aggregated at the SSO. The 4G SSO is also a pass through point for all signaling and control traffic between the cell site and the gateway/mobility management entity. 4G SSO equipment can be located at a core switch site or in a physically remote location. 4G networks utilize similar basic network building blocks to those used for 3G services.   A common IP backbone for both 3G and 4G yields additional energy savings.

The LTE core wireless site supports voice and data traffic, signaling and control functions, and mobility management functions for the eNodeBs that it serves. The 4G architecture utilizes packet gateways that can reside at the same physical location as the MME or at a different physical location. Typical core site network components include the Mobility Management Entity (MME), Service Gateway (SGW), Packet Gateway (PGW), and Combined Packet Gateway (CPG). The inherent flexibility of this architecture enables Sprint to diversify network resources and place them at locations which make the most efficient use of available building and network resources.

Through the use of IP networking, as shown in *figure two*, the overall Network Vision architecture allows Sprint to more efficiently carry subscriber data and voice traffic, creating energy savings opportunities. The Network Vision concept allows Sprint to easily overlay additional services such as Push-to-Talk services on a single network, eliminating redundant networks. The ability to share efficient IP-based network resources enables Sprint to reduce the number of buildings needed in the network to support customer requirements.

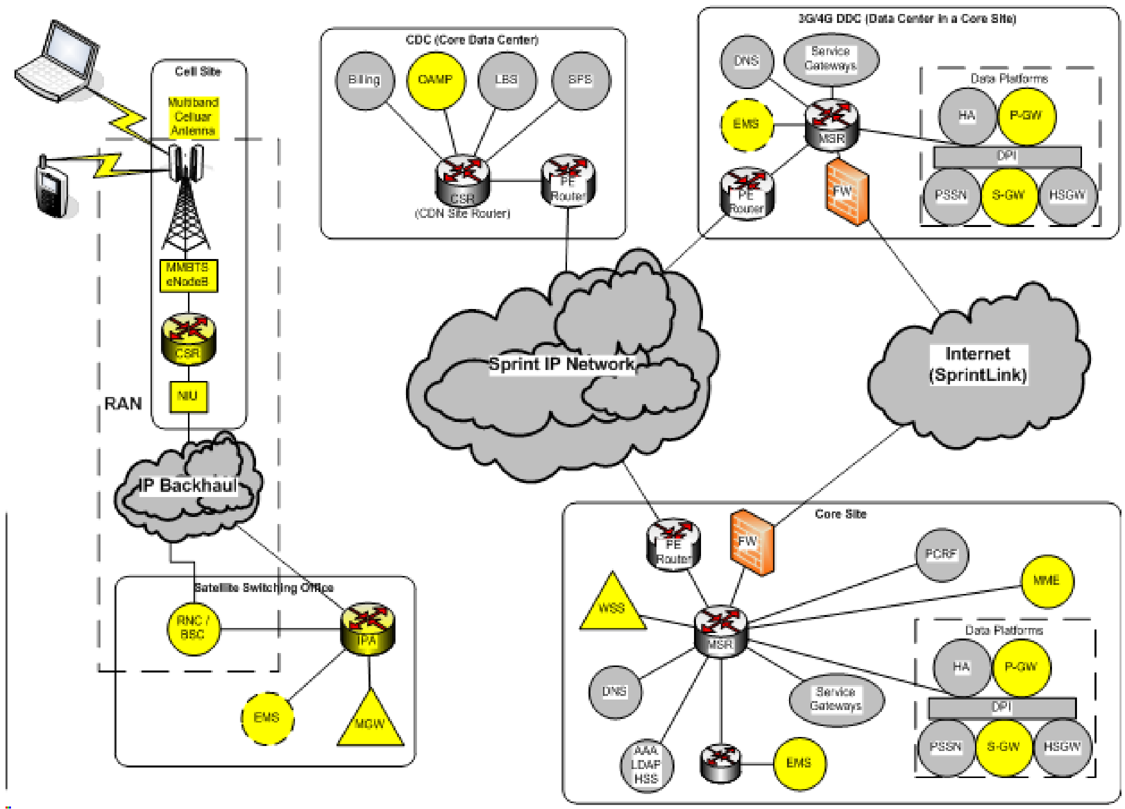

Figure 2- Generic Network Vision Architecture

Conclusion

Early on Sprint recognized that our greatest opportunity for energy savings opportunities would not come not from individual building specific energy efficiency design changes such as HVAC system enhancements, but from a network redesign, allowing Sprint to reduce the number of buildings required to support its network. Through Network Vision, Sprint will be shutting down 30,000 cell sites and 48 switch sites required to support the legacy iDEN network. The transition is expected to substantially complete in 2013. By year-end 2014, Sprint expects to save more than 1.27 Billion kWh hours of energy consumption and 782 MT of CO2-e of greenhouse gas emissions annually. Exponentially increasing wireless subscriber LTE bandwidth demands will offset those gains over time to some degree; however, through continued aggressive management of energy consumption and innovative network and building energy design improvements, Sprint expects to meet the 20% absolute electrical use reduction challenge and its commitment to the DOE and the Better Buildings Program.

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[i] On Greening Cellular Networks Via Multicell Cooperation, Tao Han and Nirwan Ansari, New Jersey Institute of Technology, IEEE Comsoc, April 16, 2013.

[ii] Energy Efficient, Scalable Packet Transport Networks, Gert J. Eilenberger, Alcatel-Lucent Deutschland AG, Bell Labs, 15th OptoElectronics and Communications Conference (OECC2010) Technical Digest, July 2010